A Simulation of Insertion and Retention Forces in Cantilever Hook Snap-Fit Joint

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Abstract

There are numerous methods for joining plastic parts together, including adhesive bonding, mechanical fastening and snap-fit. Snap-fit is used in this study to assemble plastic parts because it is an effective, cost-effective and fast joining technique. When it comes to snap-fits, there are two options: separable and inseparable. Separable indicates that the pieces may be disassembled effectively without breaking, whereas inseparable means that the plastic parts are permanently joined.This study focuses on cantilever snap-fit since it is widely utilized in the automobile, aerospace and other industries. There are numerous parameters that influence the functionality of snap-fits, particularly the forces of insertion and retention. The parameters are the feature thickness (Tb), beam length (Lb), beam width (Wb), base radius (Rb), mounting (α) and dismounting angle (β). The increase of insertion and retention angle is believed to increase the forces required to joint and disjoint the cantilever hook snap-fit.

1. Introduction

Several joining methods can be used to join two or more parts together such as adhesive bonding, mechanical fasteners and snap-fit and each of these techniques has its specific functions, suitability and limitations. Snap-fit can be used to substitute the standard threaded fasteners during the assembly of plastic parts as recommended by Design for Assembly (DFA) [1] because they can be installed faster and with less pressure on the body than conventional fasteners. Snap-fit is a low-cost and quick method to join flexible parts together and is commonly used in manufacturing. The use of snap-fits can be seen in daily life such as the battery cover of remote control, pen cap, and door handle bezel. Additionally, snap-fit design is able to eliminate the need for external energy sources that can also reduce the inventory of components. Snap-fit comprises of one male and one female part, and words such as the insertion and retention forces, as well as the locking ratio, must be addressed throughout the assembly and disassembly process of cantilever snap-fit. To simulate the model for these forces, several parameters are crucial which affect the results obtained. There are many mechanical failure mechanisms for cantilever hooks that correlate to the retention force applied in relation to the percentage of engagement between the cantilever snap-fit pieces. As a result, it is critical to explore the influence of design factors on the mating forces. The optimum parameters for designing cantilever snap-fit are the key to this research. There is a higher chance on the frequent change of snap-fit as it is impossible to reconstruct since it is prone to fatigue fracture and resulting in the failure of the component's joint. The cantilever hook joint design can induce a loss of engagement without any material failure. The dimensions for the snap-fit design have a significant impact on mating performance and precision as well as increase the risk of parts' ability to sustain loads and forces. A sharp corner between the snap-fit beam and wall can initiate high-stress concentration as it generates stress beyond the material strength. All these causes and effects required a proper design and sizes of cantilever hook snap-fits.

1.1 Snap-fit

Snap-fit is a mechanically attached form-fitting joint that is frequently moulded directly into a plastic part. The joint determines the relative part placement, orientation and alignment of load transmission, and degrees of freedom. The mechanical asymmetry is a key feature of industrial snap-fits that results from the interaction of flexibility, frictional interactions and the geometric structure of the snap-fit pieces [2]. Snap-fit can be made with the intention of separable or inseparable purposes. When it is constructed properly, the pieces can be attached and detached easily for several times without damaging the assembly and material. Because of their simplicity, snap-fit is also the most ecologically friendly form of assembly, allowing various components to be recycled [3]. Snap-fit consists of a cantilever structure constructed with a hook at one end. The hook's interference with another part creates a mating force that deflects when it is assembled and that interlocks the two parts [4]. The design of snap-fit can replace the function of bolt and nut, and there is no need for use of fasteners [5]. There are several types of snap-fit in the industry and they are cantilever, torsion as well as annular snap-fit. The prominent type of snap-fit that is widely used is cantilever snap-fits. This joining method is made up of a cantilever arm with a deflect hook on the end. They usually have beneficial forms and can be composed of materials other than plastics, such as metals and fibre composites.